Seagate®

Product Manual

Barracuda

ST31000524AS
ST3750525AS
ST3500413AS
ST3320413AS
ST3250312AS
ST3160316AS

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Document Revision History

Revision	Date	Description of Change
Rev. A	08/20/2010	Initial release.
Rev. B	03/04/2011	Added Reliability section.

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1.0 Introduction

This manual describes the functional, mechanical and interface specifications for the following Seagate Barracuda® model drives:

ST31000524AS	ST3500413AS	ST3250312AS
ST3750525AS	ST3320413AS	ST3160316AS

These drives provide the following key features:

- 7200 RPM spindle speed.
- High instantaneous (burst) data-transfer rates (up to 600MB per second).
- Perpendicular recording technology provides the drives with increased areal density.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Native Command Queueing with command ordering to increase performance in demanding applications.
- Full-track multiple-sector transfer capability without local processor intervention.
- Quiet operation.
- Compliant with RoHS requirements in China and Europe.
- SeaTools diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- Support for S.M.A.R.T. drive monitoring and reporting.
- Supports latching SATA cables and connectors.
- Worldwide Name (WWN) capability uniquely identifies the drive.

1.1 About the Serial ATA interface

The Serial ATA interface provides several advantages over the traditional (parallel) ATA interface. The primary advantages include:

- Easy installation and configuration with true plug-and-play connectivity. It is not necessary to set any jumpers or other configuration options.
- Thinner and more flexible cabling for improved enclosure airflow and ease of installation.
- Scalability to higher performance levels.

In addition, Serial ATA makes the transition from parallel ATA easy by providing legacy software support. Serial ATA was designed to allow you to install a Serial ATA host adapter and Serial ATA disk drive in your current system and expect all of your existing applications to work as normal.

The Serial ATA interface connects each disk drive in a point-to-point configuration with the Serial ATA host adapter. There is no master/slave relationship with Serial ATA devices like there is with parallel ATA. If two drives are attached on one Serial ATA host adapter, the host operating system views the two devices as if they were both “masters” on two separate ports. This essentially means both drives behave as if they are Device 0 (master) devices.

Note	The host adapter may, optionally, emulate a master/slave environment to host software where two devices on separate Serial ATA ports are represented to host software as a Device 0 (master) and Device 1 (slave) accessed at the same set of host bus addresses. A host adapter that emulates a master/slave environment manages two sets of shadow registers. This is not a typical Serial ATA environment.

The Serial ATA host adapter and drive share the function of emulating parallel ATA device behavior to provide backward compatibility with existing host systems and software. The Command and Control Block registers, PIO and DMA data transfers, resets, and interrupts are all emulated.

The Serial ATA host adapter contains a set of registers that shadow the contents of the traditional device registers, referred to as the Shadow Register Block. All Serial ATA devices behave like Device 0 devices. For additional information about how Serial ATA emulates parallel ATA, refer to the “Serial ATA International Organization: Serial ATA Revision 3.0”. The specification can be downloaded from www.sata-io.org.

2.0 Drive Specifications

Unless otherwise noted, all specifications are measured under ambient conditions, at 25°C, and nominal power. For convenience, the phrases *the drive* and *this drive* are used throughout this manual to indicate the following drive models:

ST31000524AS	ST3500413AS	ST3250312AS
ST3750525AS	ST3320413AS	ST3160316AS

2.1 Specification summary tables

The specifications listed in the following tables are for quick reference. For details on specification measurement or definition, see the appropriate section of this manual.

Table 1 Drive specifications summary for 1000 and 750 models

Drive Specification	ST31000524AS	ST3750525AS
Formatted capacity (512 bytes/sector)*	1000GB	750GB
Guaranteed sectors	1,953,525,168	1,465,149,168
Heads	4	3
Disks	2	2
Bytes per sector	512	512
Default sectors per track	63	63
Default read/write heads	16	16
Default cylinders	16,383	16,383
Recording density (max)	1413kb/in	1413kb/in
Track density (avg)	236 ktracks/in	236 ktracks/in
Areal density (avg)	329Gb/in^2	329Gb/in^2
Spindle speed	7200 RPM	7200 RPM
Internal data transfer rate (max)	1695Mb/s	1695Mb/s
Sustained data transfer rate OD (max)	125MB/s	125MB/s
I/O data-transfer rate (max)	600MB/s	600MB/s
ATA data-transfer modes supported	PIO modes: 0 to 4 Multiword DMA modes: 0 to 2 Ultra DMA modes: 0 to 6	
Cache buffer	32MB	32MB
Height (max.)	26.1mm / 1.028 in	26.1mm / 1.028 in
Width (max.)	101.6mm /4.0 in (± 0.010 in)	101.6mm /4.0 in (± 0.010 in)
Length (max.)	146.99mm / 5.787 in	146.99mm / 5.787 in
Weight (typical)	622g /1.371 lb	622g /1.371 lb
Average latency	4.16ms	4.16ms
Power-on to ready (max.)	<10.0s	<10.0s
Standby to ready (max.)	<10.0s	<10.0s
Track-to-track seek time (typical)	<1.0ms read <1.2ms write	<1.0ms read <1.2ms write
Average seek, read (typical) Average seek, write (typical)	<8.5ms typical <9.5ms typical	<8.5ms typical <9.5ms typical

Table 1 Drive specifications summary for 1000 and 750 models (continued)

Drive Specification	ST31000524AS	ST3750525AS
Startup current (typical) 12V (peak)	2.0A	2.0A
Voltage tolerance (including noise)	5V +10% / -7.5% 12V +10% / -7.5%	5V +10% / -7.5% 12V +10% / -7.5%
Ambient temperature	0° to 60°C (operating) –40° to 70°C (non-operating)	0° to 60°C (operating) –40° to 70°C (non-operating)
Temperature gradient	20°C per hour max (operating) 30°C per hour max (non-operating)	20°C per hour max (operating) 30°C per hour max (non-operating)
Relative humidity	5% to 95% (operating) 5% to 95% (non-operating)	5% to 95% (operating) 5% to 95% (non-operating)
Relative humidity gradient (max.)	30% per hour	30% per hour
Wet bulb temperature (max.)	37.7°C max (operating) 40.0°C max (non-operating)	37.7°C max (operating) 40.0°C max (non-operating)
Altitude, operating	–304.8m to 3,048m (–1000 ft to 10,000+ ft)	–304.8m to 3,048m (–1000 ft to 10,000+ ft)
Altitude, non-operating (below mean sea level, max)	–304.8m to 12,192m (–1000 ft to 40,000+ ft)	–304.8m to 12,192m (–1000 ft to 40,000+ ft)
Operational Shock (max)	70 Gs at 2ms	70 Gs at 2ms
Non-Operational Shock (max)	300 Gs at 2ms	300 Gs at 2ms
Vibration, operating	2Hz to 22Hz: 0.25 Gs, Limited displace-ment 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs	2Hz to 22Hz: 0.25 Gs, Limited displacement 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs
Vibration, non-operating	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs
Drive acoustics, sound power		
Idle**	2.6 bels (typical) 2.7 bels (max)	2.6 bels (typical) 2.7 bels (max)
Seek	2.8 bels (typical) 3.0 bels (max)	2.8 bels (typical) 3.0 bels (max)
Non-recoverable read errors	1 per 10^{14} bits read	1 per 10^{14} bits read
Annulized Failure Rate (AFR)	0.34%	0.34%
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: support.seagate.com/customer/warranty_validation.jsp From this page, click on the “Verify Your Warranty” link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for your drive.	
Contact start-stop cycles	50,000 at 25°C, 50% rel. humidity	50,000 at 25°C, 50% rel. humidity
Supports Hotplug operation per the Serial ATA Revision 2.5 specification	Yes	Yes

*One GB equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

**During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

Table 2 Drive specifications summary for 500GB and 320 models

Drive Specification	ST3500413AS	ST3320413AS
Formatted capacity (512 bytes/sector)*	500GB	320GB
Guaranteed sectors	976,773,168	625,142,448
Heads	2	2
Disks	1	1
Bytes per sector	512	512
Default sectors per track	63	63
Default read/write heads	16	16
Default cylinders	16,383	16,383

Table 2 Drive specifications summary for 500GB and 320 models (continued)

Drive Specification	ST3500413AS	ST3320413AS
Recording density (max.)	1413kb/in	1413kb/in
Track density (avg.)	236 ktracks/in	236 ktracks/in
Areal density (avg.)	329Gb/in^2	329Gb/in^2
Spindle speed	7200 RPM	7200 RPM
Internal data transfer rate (max)	1695Mb/s	1695Mb/s
Sustained data transfer rate OD (max)	125MB/s	125MB/s
I/O data-transfer rate (max.)	600MB/s	600MB/s
ATA data-transfer modes supported	PIO modes: 0 to 4 Multiword DMA modes: 0 to 2 Ultra DMA modes: 0 to 6	PIO modes: 0 to 4 Multiword DMA modes: 0 to 2 Ultra DMA modes: 0 to 6
Cache buffer	16MB	16MB
Height (max)	19.98mm / 0.787 in	19.98mm / 0.787 in
Width (max)	101.6mm / 4.0 in (± 0.010 in)	101.6mm / 4.0 in (± 0.010 in)
Length (max)	146.99mm / 5.787 in	146.99mm / 5.787 in
Weight (typical)	415g / 0.915 lb	415g / 0.915 lb
Average latency	4.16ms	4.16ms
Power-on to ready (max)	<8.5s	<8.5s
Standby to ready (max)	<8.5s	<8.5s
Track-to-track seek time (typical)	<1.0ms read; <1.2ms write	<1.0ms read; <1.2ms write
Average seek, read (typical)	<8.5ms	<8.5ms
Average seek, write (typical)	<9.5ms	<9.5ms
Startup current (typical) 12V (peak)	2.0A	2.0A
Voltage tolerance (including noise)	5V +10% / -7.5% 12V +10% / -7.5%	5V +10% / -7.5% 12V +10% / -7.5%
Ambient temperature	0° to 60°C (operating) –40° to 70°C (non-operating)	0° to 60°C (operating) –40° to 70°C (non-operating)
Temperature gradient	20°C per hour max (operating) 30°C per hour max (non-operating)	20°C per hour max (operating) 30°C per hour max (non-operating)
Relative humidity	5% to 95% (operating) 5% to 95% (non-operating)	5% to 95% (operating) 5% to 95% (non-operating)
Relative humidity gradient (max)	30% per hour	30% per hour
Wet bulb temperature (max)	37.7°C (operating) 40.0°C (non-operating)	37.7°C (operating) 40.0°C (non-operating)
Altitude, operating	–304.8m to 3,048m (–1000 ft to 10,000+ ft)	–304.8m to 3,048m (–1000 ft to 10,000+ ft)
Altitude, non-operating (below mean sea level, max)	–304.8m to 12,192m (–1000 ft to 40,000+ ft)	–304.8m to 12,192m (–1000 ft to 40,000+ ft)
Operational Shock (max)	70 Gs at 2ms	70 Gs at 2ms
Non-Operational Shock (max)	350 Gs at 2ms	350 Gs at 2ms
Vibration, operating	2Hz to 22Hz: 0.25 Gs, Limited displacement 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs	2Hz to 22Hz: 0.25 Gs, Limited displacement 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs
Vibration, non-operating	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs
Drive acoustics, sound power		
Idle**	2.6 bels (typical) 2.7 bels (max)	2.6 bels (typical) 2.7 bels (max)
Seek	2.8 bels (typical) 3.0 bels (max)	2.8 bels (typical) 3.0 bels (max)
Non-recoverable read errors	1 per 10^{14} bits read	1 per 10^{14} bits read
Annulized Failure Rate (AFR)	0.34%	0.34%

Table 2 Drive specifications summary for 500GB and 320 models (continued)

Drive Specification	ST3500413AS	ST3320413AS
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: support.seagate.com/customer/warranty_validation.jsp From this page, click on the “Verify Your Warranty” link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for your drive.	
Contact start-stop cycles	50,000 at 25°C, 50% rel. humidity	50,000 at 25°C, 50% rel. humidity
Supports Hotplug operation per the Serial ATA Revision 2.5 specification	Yes	Yes

*One GB equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

**During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

Table 3 Drive specifications summary for 250GB and 160GB models

Drive Specification	ST3250312AS	ST3160316AS
Formatted capacity (512 bytes/sector)*	250GB	160GB
Guaranteed sectors	488,397,168	312,581,808
Heads	1	1
Disks	1	1
Bytes per sector	512	512
Default sectors per track	63	63
Default read/write heads	16	16
Default cylinders	16,383	16,383
Recording density (max.)	1413kb/in	1413kb/in
Track density (avg.)	236 ktracks/in	236 ktracks/in
Areal density (avg.)	329Gb/in^2	329Gb/in^2
Spindle speed	7200 RPM	7200 RPM
Internal data transfer rate (max.)	1695Mb/s	1695Mb/s
Sustained data transfer rate OD (max.)	125MB/s	125MB/s
I/O data-transfer rate	600MB/s	600MB/s
ATA data-transfer modes supported	PIO modes: 0 to 4 Multiword DMA modes: 0 to 2 Ultra DMA modes: 0 to 6	PIO modes: 0 to 4 Multiword DMA modes: 0 to 2 Ultra DMA modes: 0 to 6
Cache buffer	8MB	8MB
Height (max.)	19.98mm / 0.787 in	19.98mm / 0.787 in
Width (max.)	101.6mm / 4.0 in (± 0.010 in)	101.6mm / 4.0 in (± 0.010 in)
Length (max.)	146.99mm / 5.787 in	146.99mm / 5.787 in
Weight (typical)	415g / 0.915 lb	415g / 0.915 lb
Average latency	4.16ms	4.16ms
Power-on to ready (max.)	<8.5s	<8.5s
Standby to ready (max.)	<8.5s	<8.5s
Track-to-track seek time (typical)	<1.0ms (read) <1.2ms (write)	<1.0ms (read) <1.2ms (write)
Average seek, read (typical) Average seek, write (typical)	<8.5ms (read) <9.5ms (write)	<8.5ms (read) <9.5ms (write)
Startup current (typical) 12V (peak)	2.0A	2.0A
Voltage tolerance (including noise)	5V +10% / -7.5% 12V +10% / -7.5%	5V +10% / -7.5% 12V +10% / -7.5%
Ambient temperature	0° to 60°C (operating) –40° to 70°C (non-operating)	0° to 60°C (operating) –40° to 70°C (non-operating)
Temperature gradient (max.)	20°C per hour (operating) 30°C per hour (non-operating)	20°C per hour (operating) 30°C per hour (non-operating)

Table 3 Drive specifications summary for 250GB and 160GB models (continued)

Drive Specification	ST3250312AS	ST3160316AS
Relative humidity	5% to 95% (operating) 5% to 95% (non-operating)	5% to 95% (operating) 5% to 95% (non-operating)
Relative humidity gradient (max.)	30% per hour	30% per hour
Wet bulb temperature	37.7°C max (operating) 40.0°C max (non-operating)	37.7°C max (operating) 40.0°C max (non-operating)
Altitude, operating	–60.96m to 3,048m (–1000 ft to 10,000+ ft)	–60.96m to 3,048m (–1000 ft to 10,000+ ft)
Altitude, non-operating (below mean sea level, max.)	–60.96m to 12,192m (–1000 ft to 40,000+ ft)	–60.96m to 12,192m (–1000 ft to 40,000+ ft)
Operational Shock (max.)	70 Gs at 2ms	70 Gs at 2ms
Non-Operational Shock (max.)	350 Gs at 2ms	350 Gs at 2ms
Vibration, operating	2Hz to 22Hz: 0.25 Gs, Limited displacement 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs	2Hz to 22Hz: 0.25 Gs, Limited displacement 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs
Vibration, non-operating	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs
Drive acoustics, sound power Idle**	2.6 bels (typical) 2.7 bels (max)	2.6 bels (typical) 2.7 bels (max)
Seek	2.8 bels (typical) 3.0 bels (max)	2.8 bels (typical) 3.0 bels (max)
Non-recoverable read errors	1 per 10^{14} bits read	1 per 10^{14} bits read
Annulized Failure Rate (AFR)	0.34%	0.34%
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: support.seagate.com/customer/warranty_validation.jsp From this page, click on the “Verify Your Warranty” link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for your drive.	
Contact start-stop cycles	50,000 at 25°C, 50% rel. humidity	50,000 at 25°C, 50% rel. humidity
Supports Hotplug operation per the Serial ATA Revision 2.5 specification	Yes	Yes

*One GB equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

**During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

2.2 Formatted capacity

Model	Formatted capacity*	Guaranteed sectors	Bytes per sector
ST31000524AS	1000GB	1,953,525,168	512
ST3750525AS	750GB	1,465,149,168	
ST3500413AS	500GB	976,773,168	
ST3320413AS	320GB	625,142,448	
ST3250312AS	250GB	488,397,168	
ST3160316AS	160GB	312,581,808	

*One GB equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

2.2.1 LBA mode

When addressing these drives in LBA mode, all blocks (sectors) are consecutively numbered from 0 to *n–1,* where *n* is the number of guaranteed sectors as defined above.

See Section 4.3.1, "Identify Device command" (words 60-61 and 100-103) for additional information about 48-bit addressing support of drives with capacities over 137GB.

2.3 Default logical geometry

Cylinders	Read/write heads	Sectors per track
16,383	16	63

LBA mode
When addressing these drives in LBA mode, all blocks (sectors) are consecutively numbered from 0 to *n–1,* where *n* is the number of guaranteed sectors as defined above.

2.4 Recording and interface technology

Interface	Serial ATA (SATA)
Recording method	Perpendicular
Recording density (kbits/inch max)	1413
Track density (ktracks/inch avg)	236
Areal density (Gbits/inch^2 avg)	329
Spindle speed (RPM)	7,200 ± 0.2%
Internal data transfer rate (Mb/s max)	1695
Sustained data transfer rate (MB/s max)	125
I/O data-transfer rate (MB/s max)	600

2.5 Physical characteristics

Maximum height	
1000 and 750GB models	26.1mm / 1.028 in
500, 320, 250 and 160GB models	19.98mm / 0.787 in
Maximum width	101.6mm / 4.000 (± 0.010 in)
Maximum length	146.99mm / 5.787 in
Typical weight	
1000 and 750GB models	622g / 1.371 lb
500, 320, 250 and 160GB models	415g / 0.915 lb
Cache buffer	
1000 and 750GB models	32MB (32,768kb)
500 and 320GB models	16MB (16,384kb)
250 and 160GB models	8MB (8192kb)

2.6 Seek time

Seek measurements are taken with nominal power at 25°C ambient temperature. All times are measured using drive diagnostics. The specifications in the table below are defined as follows:

- Track-to-track seek time is an average of all possible single-track seeks in both directions.
- Average seek time is a true statistical random average of at least 5,000 measurements of seeks between random tracks, less overhead.

Typical seek times (ms)	Read	Write
Track-to-track	1.0	1.2
Average	8.5	9.5
Average latency	4.16	

Note	These drives are designed to consistently meet the seek times represented in this manual. Physical seeks, regardless of mode (such as track-to-track and average), are expected to meet the noted values. However, due to the manner in which these drives are formatted, benchmark tests that include command overhead or measure logical seeks may produce results that vary from these specifications.

2.7 Start/stop times

	1000 and 750GB models	500, 320, 250 and 160GB models
Power-on to Ready (typ / max sec)	<10.0	<8.5
Standby to Ready (typ / max sec)	<10.0	<8.5
Ready to spindle stop (typ / max sec)	10	10

2.8 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. Refer to **Figure 1 on page 28** on page 28.

2.8.1 Power consumption

Power requirements for the drives are listed in **Table 4 on page 19** and **Table 5 on page 19**. Typical power measurements are based on an average of drives tested, under nominal conditions, using 5.0V and 12.0V input voltage at 25°C ambient temperature.

- Spinup power

  Spinup power is measured from the time of power-on to the time that the drive spindle reaches operating speed.

- Read/write power and current

  Read/write power is measured with the heads on track, based on a 16-sector write followed by a 32-ms delay, then a 16-sector read followed by a 32-ms delay.

- Operating power and current

  Operating power is measured using 40 percent random seeks, 40 percent read/write mode (1 write for each 10 reads) and 20 percent drive idle mode.

- Idle mode power

  Idle mode power is measured with the drive up to speed, with servo electronics active and with the heads in a random track location.

- Standby mode

  During Standby mode, the drive accepts commands, but the drive is not spinning, and the servo and read/write electronics are in power-down mode.

Table 4 DC power requirements (2-disk)

Power dissipation (2-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V typ amps
Spinup	—	—	2.0 (peak)
Idle* †	5.0	0.168	0.337
Idle* † (with offline activity)	5.40	0.153	0.387
Operating	6.57	0.496	0.341
Standby	0.79	0.35	0.01
Sleep	0.79	0.35	0.01

Table 5 DC power requirements (1-disk)

Power dissipation (1-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V typ amps
Spinup	—	—	2.0 (peak)
Idle* †	4.60	0.378	0.224
Idle* † (with offline activity)	4.50	0.250	0.240
Operating	6.19	0.656	0.243
Standby	0.79	0.35	0.01
Sleep	0.79	0.35	0.01

*During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.
†5W IDLE with DIPLM Enabled

2.8.2 Conducted noise

Input noise ripple is measured at the host system power supply across an equivalent 80-ohm resistive load on the +12 volt line or an equivalent 15-ohm resistive load on the +5 volt line.

- Using 12-volt power, the drive is expected to operate with a maximum of 120 mV peak-to-peak square-wave injected noise at up to 10MHz.
- Using 5-volt power, the drive is expected to operate with a maximum of 100 mV peak-to-peak square-wave injected noise at up to 10MHz.

Note Equivalent resistance is calculated by dividing the nominal voltage by the typical RMS read/write current.

2.8.3 Voltage tolerance

Voltage tolerance (including noise):

- 5V +10% / -7.5%
- 12V +10% / -7.5%

2.8.4 Power-management modes

The drive provides programmable power management to provide greater energy efficiency. In most systems, you can control power management through the system setup program. The drive features the following power-management modes:

Power modes	Heads	Spindle	Buffer
Active	Tracking	Rotating	Enabled
Idle	Tracking	Rotating	Enabled
Standby	Parked	Stopped	Enabled
Sleep	Parked	Stopped	Disabled

- Active mode

  The drive is in Active mode during the read/write and seek operations.
- Idle mode

  The buffer remains enabled, and the drive accepts all commands and returns to Active mode any time disk access is necessary.
- Standby mode

  The drive enters Standby mode when the host sends a Standby Immediate command. If the host has set the standby timer, the drive can also enter Standby mode automatically after the drive has been inactive for a specifiable length of time. The standby timer delay is established using a Standby or Idle command. In Standby mode, the drive buffer is enabled, the heads are parked and the spindle is at rest. The drive accepts all commands and returns to Active mode any time disk access is necessary.
- Sleep mode

  The drive enters Sleep mode after receiving a Sleep command from the host. In Sleep mode, the drive buffer is disabled, the heads are parked and the spindle is at rest. The drive leaves Sleep mode after it receives a Hard Reset or Soft Reset from the host. After receiving a reset, the drive exits Sleep mode and enters Standby mode with all current translation parameters intact.
- Idle and Standby timers

  Each time the drive performs an Active function (read, write or seek), the standby timer is reinitialized and begins counting down from its specified delay times to zero. If the standby timer reaches zero before any drive activity is required, the drive makes a transition to Standby mode. In both Idle and Standby mode, the drive accepts all commands and returns to Active mode when disk access is necessary.

2.9 Environmental specifications

2.9.1 Ambient temperature

Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Actual drive case temperature should not exceed 69°C (156°F) within the operating ambient conditions.

Operating:	0° to 60°C (32° to 140°F)
Non-operating:	–40° to 70°C (–40° to 158°F)

2.9.2 Temperature gradient

Operating:	20°C per hour (68°F per hour max), without condensation
Non-operating:	30°C per hour (86°F per hour max)

2.9.3 Humidity

2.9.3.1 Relative humidity

Operating:	5% to 95% non-condensing (30% per hour max)
Nonoperating:	5% to 95% non-condensing (30% per hour max)

2.9.3.2 Wet bulb temperature

Operating:	37.7°C (99.9°F max)
Non-operating:	40°C (104°F max)

2.9.4 Altitude

Operating:	–304.8 m to 3,048 m (–1000 ft. to 10,000+ ft.)
Non-operating:	–304.8 m to 12,192 m (–1000 ft. to 40,000+ ft.)

2.9.5 Shock

All shock specifications assume that the drive is mounted securely with the input shock applied at the drive mounting screws. Shock may be applied in the X, Y or Z axis.

2.9.5.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 70 Gs based on half-sine shock pulses of 2 ms during read operations. Shocks should not be repeated more than two times per second.

2.9.5.2 Non-operating shock

1000 and 750GB models

The non-operating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 300 Gs based on a non-repetitive half-sine shock pulse of 2 ms duration.

500, 320, 250 and 160GB models

The non-operating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 350 Gs based on a non-repetitive half-sine shock pulse of 2-ms duration.

2.9.6 Vibration

All vibration specifications assume that the drive is mounted securely with the input vibration applied at the drive mounting screws. Vibration may be applied in the X, Y or Z axis.

2.9.6.1 Operating vibration

The maximum vibration levels that the drive may experience while meeting the performance standards specified in this document are specified below.

2Hz to 22Hz	0.25 Gs (Limited displacement)
22Hz to 350Hz	0.50 Gs
350Hz to 500Hz	0.25 Gs

2.9.6.2 Non-operating vibration

The maximum non-operating vibration levels that the drive may experience without incurring physical damage or degradation in performance when subsequently put into operation are specified below.

5Hz to 22Hz	3.0 Gs (Limited displacement)
22Hz to 350Hz	3.0 Gs
350Hz to 500Hz	3.0 Gs

2.10 Acoustics

Drive acoustics are measured as overall A-weighted acoustic sound power levels (no pure tones). All measurements are consistent with ISO document 7779. Sound power measurements are taken under essentially free-field conditions over a reflecting plane. For all tests, the drive is oriented with the cover facing upward.

Note	For seek mode tests, the drive is placed in seek mode only. The number of seeks per second is defined by the following equation: (Number of seeks per second = 0.4 / (average latency + average access time

Table 6 Fluid Dynamic Bearing (FDB) motor acoustics

	Idle*	**Seek**
All models	2.6 bels (typ) 2.7 bels (max)	2.8 bels (typ) 3.0 bels (max)

*During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

2.10.1 Test for Prominent Discrete Tones (PDTs)

Seagate follows the ECMA-74 standards for measurement and identification of PDTs. An exception to this process is the use of the absolute threshold of hearing. Seagate uses this threshold curve (originated in ISO 389-7) to discern tone audibility and to compensate for the inaudible components of sound prior to computation of tone ratios according to Annex D of the ECMA-74 standards.

2.11 Electromagnetic immunity

When properly installed in a representative host system, the drive operates without errors or degradation in performance when subjected to the radio frequency (RF) environments defined in the following Table 7:

Table 7 Radio frequency environments

Test	Description	Performance level	Reference standard
Electrostatic discharge	Contact, HCP, VCP: ± 4 kV; Air: ± 8 kV	B	EN61000-4-2: 95
Radiated RF immunity	80MHz to 1,000MHz, 3 V/m, 80% AM with 1kHz sine 900MHz, 3 V/m, 50% pulse modulation @ 200Hz	A	EN61000-4-3: 96 ENV50204: 95
Electrical fast transient	± 1 kV on AC mains, ± 0.5 kV on external I/O	B	EN61000-4-4: 95
Surge immunity	± 1 kV differential, ± 2 kV common, AC mains	B	EN61000-4-5: 95
Conducted RF immunity	150kHz to 80MHz, 3 Vrms, 80% AM with 1kHz sine	A	EN61000-4-6: 97
Voltage dips, interrupts	0% open, 5 seconds 0% short, 5 seconds 40%, 0.10 seconds 70%, 0.01 seconds	C C C B	EN61000-4-11: 94

2.12 Reliability

The product shall achieve an Annualized Failure Rate (AFR) of 0.34% (MTBF of 0.75 million hours) when operated in an environment of ambient air temperatures of 25°C. Operation at temperatures outside the specifications in Section 2.9 may increase the product AFR (decrease MTBF). AFR and MTBF are population statistics that are not relevant to individual units.

AFR and MTBF specifications are based on the following assumptions for desktop personal computer environments:

- 2400 power-on-hours per year.
- 10,000 average motor start/stop cycles per year.
- Operations at nominal voltages.
- Temperatures outside the specifications in Section 2.9 may reduce the product reliability.
- Normal I/O duty cycle for desktop personal computers. Operation at excessive I/O duty cycle may degrade product reliability.

The desktop personal computer environment of power-on-hours, temperature, and I/O duty cycle affect the product AFR and MTBF. The AFR and MTBF will be degraded if used in an enterprise application

Nonrecoverable read errors	1 per 10^{14} bits read, max
Annualized Failure Rate (AFR)	0.34% (nominal power, 25°C ambient temperature)
Contact start-stop cycles	50,000 cycles (at nominal voltage and temperature, with 60 cycles per hour and a 50% duty cycle)
Preventive maintenance	None required.

2.13 Warranty

To determine the warranty for a specific drive, use a web browser to access the following web page:
support.seagate.com/customer/warranty_validation.jsp

From this page, click on the "Verify Your Warranty" link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for your drive.

2.14 Agency certification

2.14.1 Safety certification

These products are certified to meet the requirements of UL60950-1, CSA60950-1 and EN60950 and so marked as to the certify agency.

2.14.2 Electromagnetic compatibility

Hard drives that display the CE mark comply with the European Union (EU) requirements specified in the Electromagnetic Compatibility Directive (2004/108/EC) as put into place 20 July 2007. Testing is performed to the levels specified by the product standards for Information Technology Equipment (ITE). Emission levels are defined by EN 55022, Class B and the immunity levels are defined by EN 55024.

Drives are tested in representative end-user systems. Although CE-marked Seagate drives comply with the directives when used in the test systems, we cannot guarantee that all systems will comply with the directives. The drive is designed for operation inside a properly designed enclosure, with properly shielded I/O cable (if necessary) and terminators on all unused I/O ports. Computer manufacturers and system integrators should confirm EMC compliance and provide CE marking for their products.

Korean RRL

If these drives have the Korean Communications Commission (KCC) logo, they comply with paragraph 1 of Article 11 of the Electromagnetic Compatibility control Regulation and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Radio Research Laboratory (RRL) Communications Commission, Republic of Korea.

These drives have been tested and comply with the Electromagnetic Interference/Electromagnetic Susceptibility (EMI/EMS) for Class B products. Drives are tested in a representative, end-user system by a Korean-recognized lab.

- Family name: Barracuda 7200.12
- Certificate number: STX - 720012 (B)

Australian C-Tick (N176)

If these models have the C-Tick marking, they comply with the Australia/New Zealand Standard AS/NZ CISPR22 and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communication Authority (ACA).

2.14.3 FCC verification

These drives are intended to be contained solely within a personal computer or similar enclosure (not attached as an external device). As such, each drive is considered to be a subassembly even when it is individually marketed to the customer. As a subassembly, no Federal Communications Commission verification or certification of the device is required.

Seagate has tested this device in enclosures as described above to ensure that the total assembly (enclosure, disk drive, motherboard, power supply, etc.) does comply with the limits for a Class B computing device, pursuant to Subpart J, Part 15 of the FCC rules. Operation with non-certified assemblies is likely to result in interference to radio and television reception.

Radio and television interference. This equipment generates and uses radio frequency energy and if not installed and used in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception.

This equipment is designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television, which can be determined by turning the equipment on and off, you are encouraged to try one or more of the following corrective measures:

- Reorient the receiving antenna.
- Move the device to one side or the other of the radio or TV.
- Move the device farther away from the radio or TV.
- Plug the computer into a different outlet so that the receiver and computer are on different branch outlets.

If necessary, you should consult your dealer or an experienced radio/television technician for additional suggestions. You may find helpful the following booklet prepared by the Federal Communications Commission: *How to Identify and Resolve Radio-Television Interference Problems*. This booklet is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Refer to publication number 004-000-00345-4.

2.15 Environmental protection

Seagate designs its products to meet environmental protection requirements worldwide, including regulations restricting certain chemical substances.

2.15.1 European Union Restriction of Hazardous Substances (RoHS) Directive

The European Union Restriction of Hazardous Substances (RoHS) Directive, restricts the presence of chemical substances, including Lead, Cadmium, Mercury, Hexavalent Chromium, PBB and PBDE, in electronic products, effective July 2006. This drive is manufactured with components and materials that comply with the RoHS Directive.

2.15.2 China Restriction of Hazardous Substances (RoHS) Directive 中国限制危险物品的指令

This product has an Environmental Protection Use Period (EPUP) of 20 years. The following table contains information mandated by China's "Marking Requirements for Control of Pollution Caused by Electronic Information Products" Standard.

该产品具有20年的环境保护使用周期 （EPUP）。 下表包含了中国 “电子产品所导致的污染的控制的记号要求” 所指定的信息。

Name of Parts 部件名称	Toxic or Hazardous Substances or Elements有毒有害物质或元素					
	Lead 铅 (Pb)	Mercury 汞 (Hg)	Cadmium 镉 (Cd)	Hexavalent Chromium 六价铬 (Cr6+)	Polybrominated Diphenyl 多溴联苯 (PBB)	Polybrominated Diphenyl Ether 多溴二苯醚 (PBDE)
PCBA	X	O	O	O	O	O
HDA	X	O	O	O	O	O

"O" indicates the hazardous and toxic substance content of the part (at the homogenous material level) is lower than the threshold defined by the China RoHS MCV Standard.

“O”表示该部件（于同类物品程度上）所含的危险和有毒物质低于中国RoHS MCV标准所定义的门槛值。

"X" indicates the hazardous and toxic substance content of the part (at the homogenous material level) is over the threshold defined by the China RoHS MCV Standard.

“X”表示该部件（于同类物品程度上）所含的危险和有毒物质超出中国RoHS MCV标准所定义的门槛值。

2.16 Corrosive environment

Seagate electronic drive components pass accelerated corrosion testing equivalent to 10 years exposure to light industrial environments containing sulfurous gases, chlorine and nitric oxide, classes G and H per ASTM B845. However, this accelerated testing cannot duplicate every potential application environment. Users should use caution exposing any electronic components to uncontrolled chemical pollutants and corrosive chemicals as electronic drive component reliability can be affected by the installation environment. The silver, copper, nickel and gold films used in Seagate products are especially sensitive to the presence of sulfide, chloride, and nitrate contaminants. Sulfur is found to be the most damaging. In addition, electronic components should never be exposed to condensing water on the surface of the printed circuit board assembly (PCBA) or exposed to an ambient relative humidity greater than 95%. Materials used in cabinet fabrication, such as vulcanized rubber, that can outgas corrosive compounds should be minimized or eliminated. The useful life of any electronic equipment may be extended by replacing materials near circuitry with sulfide-free alternatives.

3.0 Configuring and Mounting the Drive

This section contains the specifications and instructions for configuring and mounting the drive.

3.1 Handling and static-discharge precautions

After unpacking, and before installation, the drive may be exposed to potential handling and electrostatic discharge (ESD) hazards. Observe the following standard handling and static-discharge precautions:

Caution

- Before handling the drive, put on a grounded wrist strap, or ground yourself frequently by touching the metal chassis of a computer that is plugged into a grounded outlet. Wear a grounded wrist strap throughout the entire installation procedure.
- Handle the drive by its edges or frame *only*.
- The drive is extremely fragile—handle it with care. Do not press down on the drive top cover.
- Always rest the drive on a padded, antistatic surface until you mount it in the computer.
- Do not touch the connector pins or the printed circuit board.
- Do not remove the factory-installed labels from the drive or cover them with additional labels. Removal voids the warranty. Some factory-installed labels contain information needed to service the drive. Other labels are used to seal out dirt and contamination.

3.2 Configuring the drive

Each drive on the Serial ATA interface connects point-to-point with the Serial ATA host adapter. There is no master/slave relationship because each drive is considered a master in a point-to-point relationship. If two drives are attached on one Serial ATA host adapter, the host operating system views the two devices as if they were both “masters” on two separate ports. Both drives behave as if they are Device 0 (master) devices.

Serial ATA drives are designed for easy installation. It is usually not necessary to set any jumpers on the drive for proper operation; however, if you connect the drive and receive a “drive not detected” error, your SATA-equipped motherboard or host adapter may use a chipset that does not support SATA speed autonegotiation.

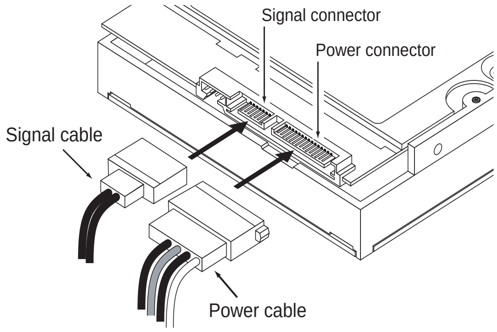
3.3 Serial ATA cables and connectors

The Serial ATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 inches). See **Table 8** for connector pin definitions. Either end of the SATA signal cable can be attached to the drive or host.

For direct backplane connection, the drive connectors are inserted directly into the host receptacle. The drive and the host receptacle incorporate features that enable the direct connection to be hot pluggable and blind mateable.

For installations which require cables, you can connect the drive as illustrated in **Figure 1**.

Figure 1 **Attaching SATA cabling**



Each cable is keyed to ensure correct orientation. Barracuda drives support latching SATA connectors.

3.4 Drive mounting

You can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. See **Figure 2** and **Figure 3** for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

- Allow a minimum clearance of 0.030 inches (0.76mm) around the entire perimeter of the drive for cooling.
- Use only 6-32 UNC mounting screws.
- The screws should be inserted no more than 0.150 inch (3.81mm) into the bottom or side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 6 inch-lb).

Figure 2 Mounting dimensions (1000 and 750GB models)

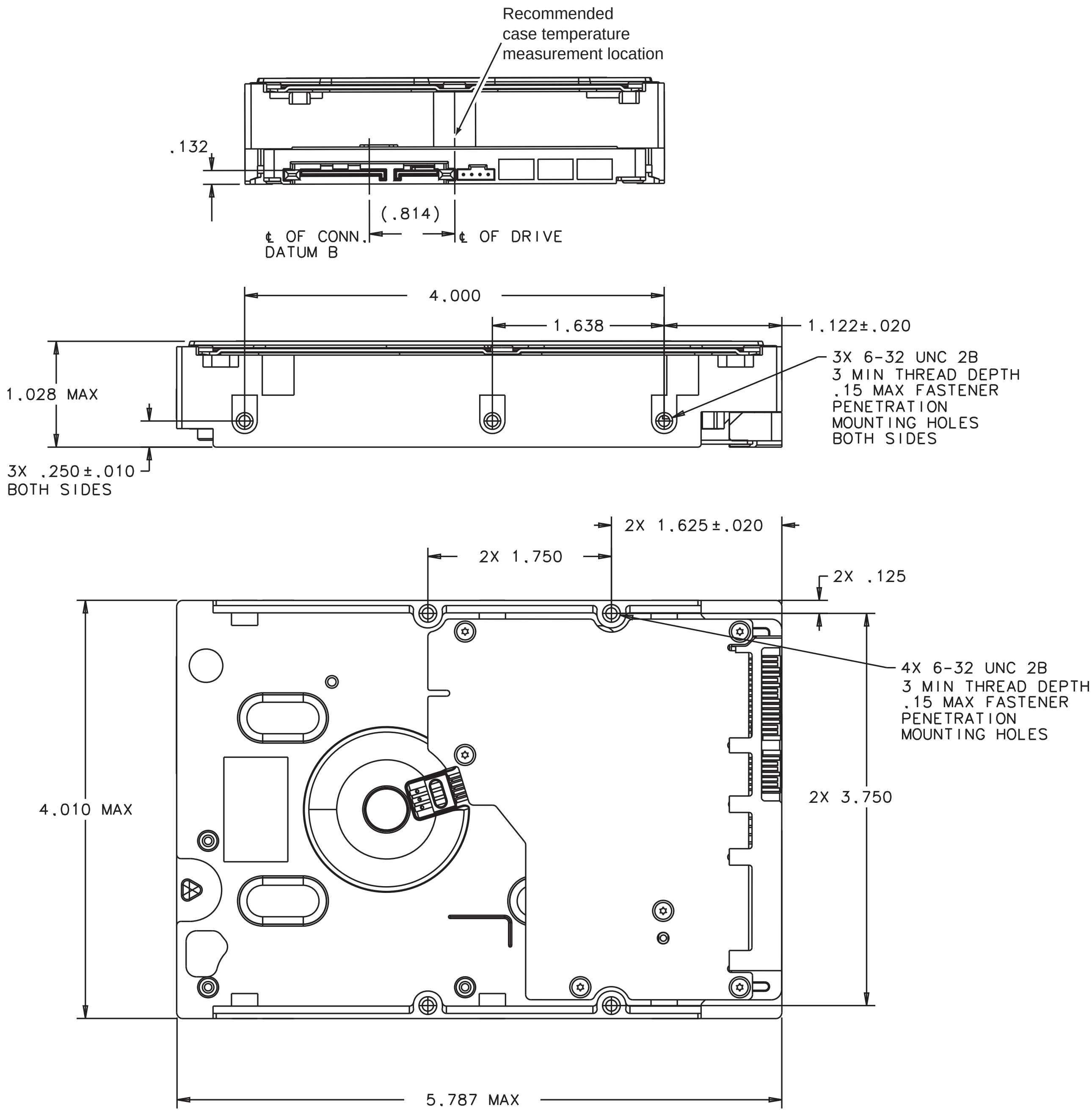
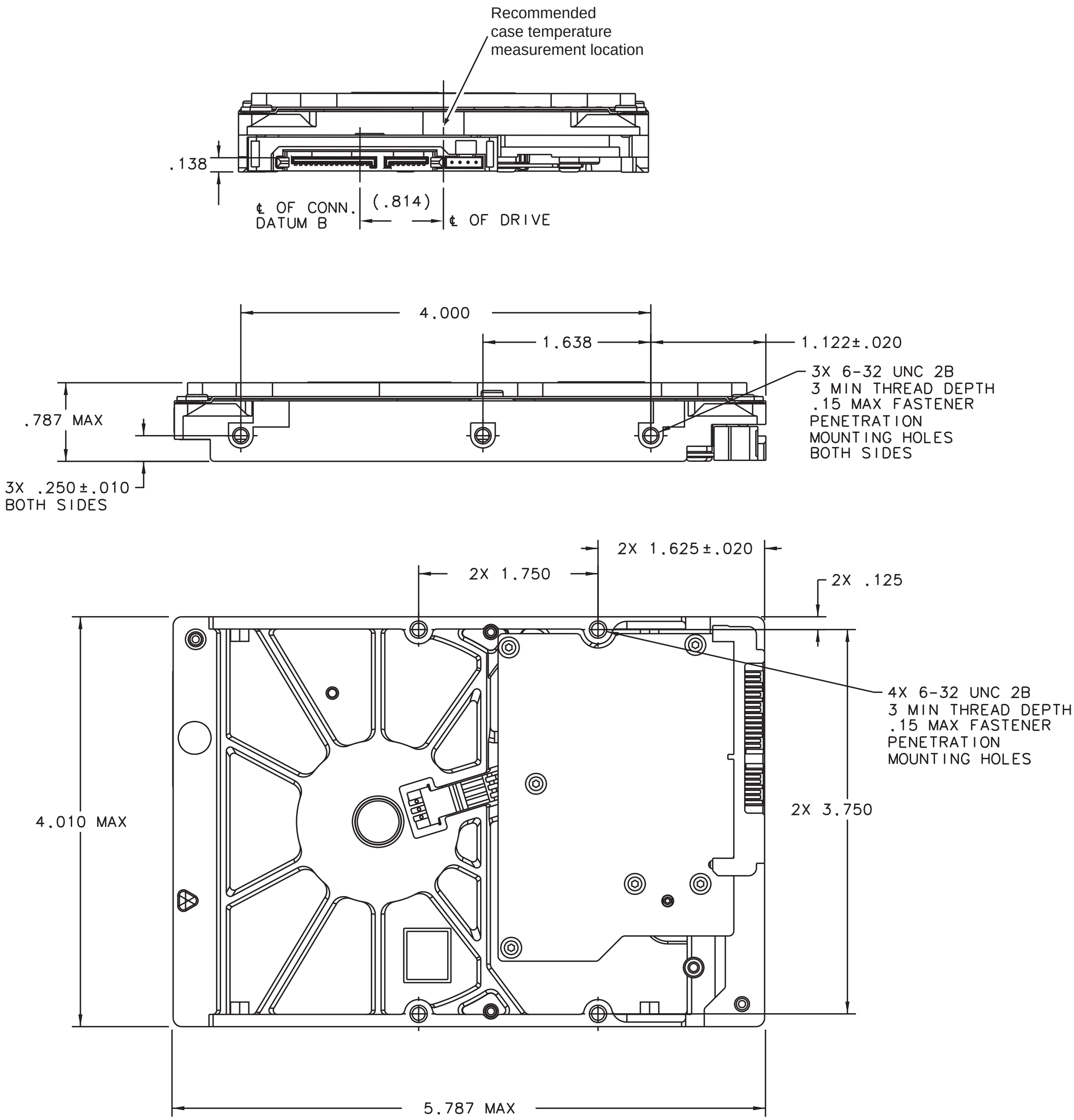


Figure 3 Mounting dimensions (500, 320, 250 and 160GB models)



4.0 Serial ATA (SATA) Interface

These drives use the industry-standard Serial ATA interface that supports FIS data transfers. It supports ATA programmed input/output (PIO) modes 0 to 4; multiword DMA modes 0 to 2, and Ultra DMA modes 0 to 6.

For detailed information about the Serial ATA interface, refer to the “Serial ATA: High Speed Serialized AT Attachment” specification.

4.1 Hot-Plug compatibility

Barracuda drives incorporate connectors which enable you to hot plug these drives in accordance with the Serial ATA Revision 2.5 specification. This specification can be downloaded from www.serialata.org.

4.2 Serial ATA device plug connector pin definitions

Table 8 summarizes the signals on the Serial ATA interface and power connectors.

Table 8 Serial ATA connector pin definitions

Segment	Pin	Function	Definition
	S1	Ground	2nd mate
	S2	A+	Differential signal pair A from Phy
	S3	A-	
	S4	Ground	2nd mate
	S5	B-	Differential signal pair B from Phy
	S6	B+	
Signal	S7	Ground	2nd mate
Key and spacing separate signal and power segments			

Table 8 Serial ATA connector pin definitions

Segment	Pin	Function	Definition
Power	P1	V_{33}	3.3V power
	P2	V_{33}	3.3V power
	P3	V_{33}	3.3V power, pre-charge, 2nd mate
	P4	Ground	1st mate
	P5	Ground	2nd mate
	P6	Ground	2nd mate
	P7	V_5	5V power, pre-charge, 2nd mate
	P8	V_5	5V power
	P9	V_5	5V power
	P10	Ground	2nd mate
	P11	Ground or LED signal	If grounded, drive does not use deferred spin
	P12	Ground	1st mate.
	P13	V_{12}	12V power, pre-charge, 2nd mate
	P14	V_{12}	12V power
	P15	V_{12}	12V power

Notes

1. All pins are in a single row, with a 1.27 mm (0.050") pitch.
2. The comments on the mating sequence apply to the case of backplane blindmate connector only. In this case, the mating sequences are:
   - the ground pins P4 and P12.
   - the pre-charge power pins and the other ground pins.
   - the signal pins and the rest of the power pins.
3. There are three power pins for each voltage. One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.
   - All used voltage pins (V_x) must be terminated.

4.3 Supported ATA commands

The following table lists Serial ATA standard commands that the drive supports.
For a detailed description of the ATA commands, refer to the Serial ATA International Organization:
Serial ATA Revision 2.6 (http://www.sata-io.org).

See "S.M.A.R.T. commands" on page 40 for details and subcommands used in the S.M.A.R.T. implementation.

Command name	Command code (in hex)
Check Power Mode	$E5_H$
Device Configuration Freeze Lock	$B1_H$ / $C1_H$
Device Configuration Identify	$B1_H$ / $C2_H$
Device Configuration Restore	$B1_H$ / $C0_H$
Device Configuration Set	$B1_H$ / $C3_H$

Command name	Command code (in hex)
Device Reset	08_H
Download Microcode	92_H
Execute Device Diagnostics	90_H
Flush Cache	$E7_H$
Flush Cache Extended	EA_H
Format Track	50_H
Identify Device	EC_H
Idle	$E3_H$
Idle Immediate	$E1_H$
Initialize Device Parameters	91_H
Read Buffer	$E4_H$
Read DMA	$C8_H$
Read DMA Extended	25_H
Read DMA Without Retries	$C9_H$
Read Log Ext	$2F_H$
Read Multiple	$C4_H$
Read Multiple Extended	29_H
Read Native Max Address	$F8_H$
Read Native Max Address Extended	27_H
Read Sectors	20_H
Read Sectors Extended	24_H
Read Sectors Without Retries	21_H
Read Verify Sectors	40_H
Read Verify Sectors Extended	42_H
Read Verify Sectors Without Retries	41_H
Recalibrate	10_H
Security Disable Password	$F6_H$
Security Erase Prepare	$F3_H$
Security Erase Unit	$F4_H$
Security Freeze	$F5_H$
Security Set Password	$F1_H$
Security Unlock	$F2_H$
Seek	70_H
Set Features	EF_H

Command name	Command code (in hex)
Set Max Address Note: Individual Set Max Address commands are identified by the value placed in the Set Max Features register as defined to the right.	$F9_H$ Address: 00_H Password: 01_H Lock: 02_H Unlock: 03_H Freeze Lock: 04_H
Set Max Address Extended	37_H
Set Multiple Mode	$C6_H$
Sleep	$E6_H$
S.M.A.R.T. Disable Operations	$B0_H$ / $D9_H$
S.M.A.R.T. Enable/Disable Autosave	$B0_H$ / $D2_H$
S.M.A.R.T. Enable Operations	$B0_H$ / $D8_H$
S.M.A.R.T. Execute Offline	$B0_H$ / $D4_H$
S.M.A.R.T. Read Attribute Thresholds	$B0_H$ / $D1_H$
S.M.A.R.T. Read Data	$B0_H$ / $D0_H$
S.M.A.R.T. Read Log Sector	$B0_H$ / $D5_H$
S.M.A.R.T. Return Status	$B0_H$ / DA_H
S.M.A.R.T. Save Attribute Values	$B0_H$ / $D3_H$
S.M.A.R.T. Write Log Sector	$B0_H$ / $D6_H$
Standby	$E2_H$
Standby Immediate	$E0_H$
Write Buffer	$E8_H$
Write DMA	CA_H
Write DMA Extended	35_H
Write DMA FUA Extended	$3D_H$
Write DMA Without Retries	CB_H
Write Log Extended	$3F_H$
Write Multiple	$C5_H$
Write Multiple Extended	39_H
Write Multiple FUA Extended	CE_H
Write Sectors	30_H
Write Sectors Without Retries	31_H
Write Sectors Extended	34_H
Write Uncorrectable	45_H

4.3.1 Identify Device command

The Identify Device command (command code EC_H) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in on page 32. All reserved bits or words should be set to zero. Parameters listed with an “x” are drive-specific or vary with the state of the drive.

The following commands contain drive-specific features that may not be included in the Serial ATA specification.

Word	Description	Value
0	Configuration information: • Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved	$0C5A_H$
1	Number of logical cylinders	16,383
2	ATA-reserved	0000_H
3	Number of logical heads	16
4	Retired	0000_H
5	Retired	0000_H
6	Number of logical sectors per logical track: 63	$003F_H$
7–9	Retired	0000_H
10–19	Serial number: (20 ASCII characters, 0000_H = none)	ASCII
20	Retired	0000_H
21	Retired	0400_H
22	Obsolete	0000_H
23–26	Firmware revision (8 ASCII character string, padded with blanks to end of string)	x.xx
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010_H
48	Reserved	0000_H
49	Standard Standby timer, IORDY supported and may be disabled	$2F00_H$
50	ATA-reserved	0000_H
51	PIO data-transfer cycle timing mode	0200_H
52	Retired	0200_H
53	Words 54–58, 64–70 and 88 are valid	0007_H
54	Number of current logical cylinders	$xxxx_H$
55	Number of current logical heads	$xxxx_H$

Word	Description	Value
56	Number of current logical sectors per logical track	$xxxx_H$
57–58	Current capacity in sectors	$xxxx_H$
59	Number of sectors transferred during a Read Multiple or Write Multiple command	$xxxx_H$
60–61	Total number of user-addressable LBA sectors available (see Section 2.2 for related information) *Note: The maximum value allowed in this field is: 0FFFFFFFh (268,435,455 sectors, 137GB). Drives with capacities over 137GB will have 0FFFFFFFh in this field and the actual number of user-addressable LBAs specified in words 100-103. This is required for drives that support the 48-bit addressing feature.	0FFFFFFFh*
62	Retired	0000_H
63	Multiword DMA active and modes supported (see note following this table)	$xx07_H$
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003_H
65	Minimum multiword DMA transfer cycle time per word (120 nsec)	0078_H
66	Recommended multiword DMA transfer cycle time per word (120 nsec)	0078_H
67	Minimum PIO cycle time without IORDY flow control (240 nsec)	$00F0_H$
68	Minimum PIO cycle time with IORDY flow control (120 nsec)	0078_H
69–74	ATA-reserved	0000_H
75	Queue depth	$001F_H$
76	Serial ATA capabilities	$xxxx_H$
77	Reserved for future Serial ATA definition	$xxxx_H$
78	Serial ATA features supported	$xxxx_H$
79	Serial ATA features enabled	$xxxx_H$
80	Major version number	$003E_H$
81	Minor version number	0028_H
82	Command sets supported	$364B_H$
83	Command sets supported	$7C03_H$
84	Command sets support extension (see note following this table)	4003_H See Word 108-111 note. (4003H = 0100000000000011 binary)
85	Command sets enabled	$30xx_H$
86	Command sets enabled	0001_H

Word	Description	Value
87	Command sets enable extension	4000_H
88	Ultra DMA support and current mode (see note following this table)	$xx3F_H$
89	Security erase time	0000_H
90	Enhanced security erase time	0000_H
92	Master password revision code	$FFFE_H$
93	Hardware reset value	$xxxx_H$
95–99	ATA-reserved	0000_H
100–103	Total number of user-addressable LBA sectors available (see Section 2.2 for related information). These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFFFFh.	ST31000524AS = 1,953,525,168 ST3750525AS = 1,465,149,168 ST3500413AS = 976,773,168 ST3320413AS = 625,142,448 ST3250312AS = 488,397,168 ST3160316AS = 312,581,808
104–107	ATA-reserved	0000_H
108–111	The mandatory value of the world wide name (WWN) for the drive. NOTE: This field is valid if word 84, bit 8 is set to 1 indicating 64-bit WWN support.	Each drive will have a unique value.
112–127	ATA-reserved	0000_H
128	Security status	0001_H
129–159	Seagate-reserved	$xxxx_H$
160–254	ATA-reserved	0000_H
255	Integrity word	$xxA5_H$

Note	Advanced Power Management (APM) and Automatic Acoustic Management (AAM) features are not supported.

Note	See the bit descriptions below for words 63, 84, and 88 of the Identify Drive data.

Description (if bit is set to 1)		
	Bit	**Word 63**
	0	Multiword DMA mode 0 is supported.
	1	Multiword DMA mode 1 is supported.
	2	Multiword DMA mode 2 is supported.
	8	Multiword DMA mode 0 is currently active.
	9	Multiword DMA mode 1 is currently active.
	10	Multiword DMA mode 2 is currently active.

	Bit	Word 84
	0	SMART error login is supported.
	1	SMART self-test is supported.
	2	Media serial number is supported.
	3	Media Card Pass Through Command feature set is supported.
	4	Streaming feature set is supported.
	5	GPL feature set is supported.
	6	WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported.
	7	WRITE DMA QUEUED FUA EXT command is supported.
	8	64-bit World Wide Name is supported.
	9-10	Obsolete.
	11-12	Reserved for TLC.
	13	IDLE IMMEDIATE command with IUNLOAD feature is supported.
	14	Shall be set to 1.
	15	Shall be cleared to 0.
	Bit	**Word 88**
	0	Ultra DMA mode 0 is supported.
	1	Ultra DMA mode 1 is supported.
	2	Ultra DMA mode 2 is supported.
	3	Ultra DMA mode 3 is supported.
	4	Ultra DMA mode 4 is supported.
	5	Ultra DMA mode 5 is supported.
	6	Ultra DMA mode 6 is supported.
	8	Ultra DMA mode 0 is currently active.
	9	Ultra DMA mode 1 is currently active.
	10	Ultra DMA mode 2 is currently active.
	11	Ultra DMA mode 3 is currently active.
	12	Ultra DMA mode 4 is currently active.
	13	Ultra DMA mode 5 is currently active.
	14	Ultra DMA mode 6 is currently active.

4.3.2 Set Features command

This command controls the implementation of various features that the drive supports. When the drive receives this command, it sets BSY, checks the contents of the Features register, clears BSY and generates an interrupt. If the value in the register does not represent a feature that the drive supports, the command is aborted. Power-on default has the read look-ahead and write caching features enabled. The acceptable values for the Features register are defined as follows:

02_H	Enable write cache *(default).*
03_H	Set transfer mode (based on value in Sector Count register). Sector Count register values:
	00_H Set PIO mode to default (PIO mode 2).
	01_H Set PIO mode to default and disable IORDY (PIO mode 2).
	08_H PIO mode 0
	09_H PIO mode 1
	$0A_H$ PIO mode 2
	$0B_H$ PIO mode 3
	$0C_H$ PIO mode 4 *(default)*
	20_H Multiword DMA mode 0
	21_H Multiword DMA mode 1
	22_H Multiword DMA mode 2
	40_H Ultra DMA mode 0
	41_H Ultra DMA mode 1
	42_H Ultra DMA mode 2
	43_H Ultra DMA mode 3
	44_H Ultra DMA mode 4
	45_H Ultra DMA mode 5
	46_H Ultra DMA mode 6
10_H	Enable use of SATA features
55_H	Disable read look-ahead (read cache) feature.
82_H	Disable write cache
90_H	Disable use of SATA features
AA_H	Enable read look-ahead (read cache) feature *(default).*
$F1_H$	Report full capacity available

Note	At power-on, or after a hardware or software reset, the default values of the features are as indicated above.

4.3.3 S.M.A.R.T. commands

S.M.A.R.T. provides near-term failure prediction for disk drives. When S.M.A.R.T. is enabled, the drive monitors predetermined drive attributes that are susceptible to degradation over time. If self-monitoring determines that a failure is likely, S.M.A.R.T. makes a status report available to the host. Not all failures are predictable. S.M.A.R.T. predictability is limited to the attributes the drive can monitor. For more information on S.M.A.R.T. commands and implementation, see the *Draft ATA-5 Standard.*

SeaTools diagnostic software activates a built-in drive self-test (DST S.M.A.R.T. command for $D4_H$) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at: http://seatools.seagate.com.

This drive is shipped with S.M.A.R.T. features disabled. You must have a recent BIOS or software package that supports S.M.A.R.T. to enable this feature. The table below shows the S.M.A.R.T. command codes that the drive uses.

Code in features register	S.M.A.R.T. command
$D0_H$	S.M.A.R.T. Read Data
$D2_H$	S.M.A.R.T. Enable/Disable Attribute Autosave
$D3_H$	S.M.A.R.T. Save Attribute Values
$D4_H$	S.M.A.R.T. Execute Off-line Immediate (runs DST)
$D5_H$	S.M.A.R.T. Read Log Sector
$D6_H$	S.M.A.R.T. Write Log Sector
$D8_H$	S.M.A.R.T. Enable Operations
$D9_H$	S.M.A.R.T. Disable Operations
DA_H	S.M.A.R.T. Return Status

Note	If an appropriate code is not written to the Features Register, the command is aborted and 0*x*04 (abort) is written to the Error register.

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